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U.S. FISH & WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR

Alaska Fish and Wildlife
Research Center

Research Highlights

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Fiscal Year 1992

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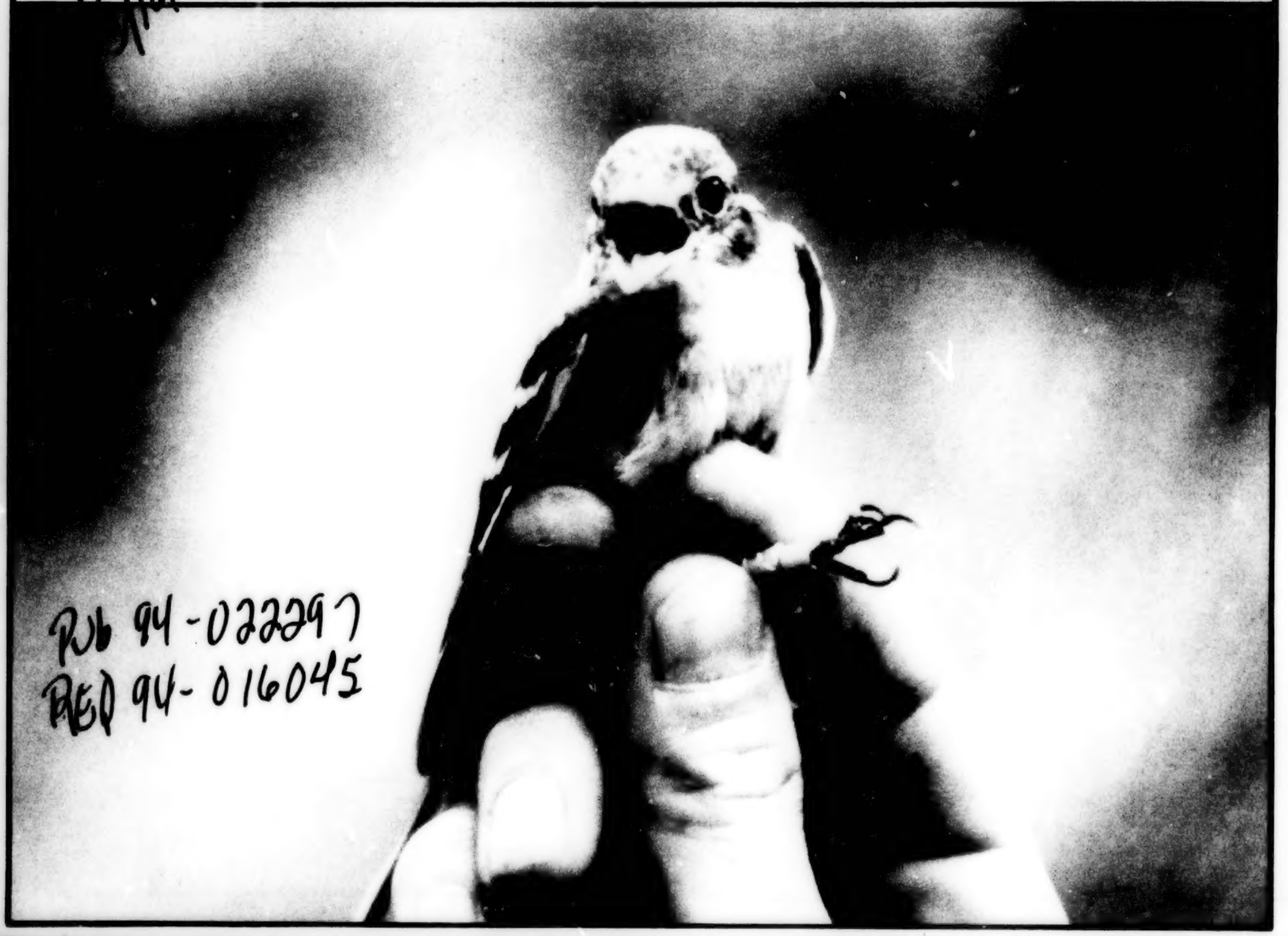

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INTRODUCTION

The Alaska Fish and Wildlife Research Center plans and conducts field and laboratory research on fish, wildlife and their habitats in Alaska. The Center also serves as a focal point for coordination with other federal and state agencies and with fish and wildlife management programs conducted by the Alaska Region of the U.S. Fish and Wildlife Service.

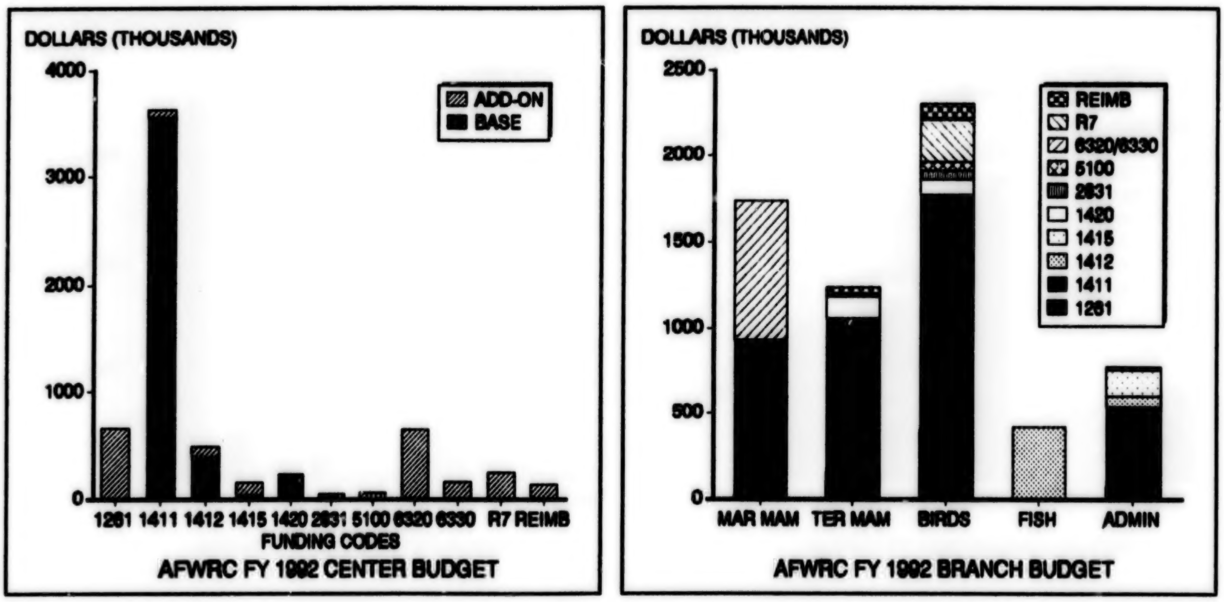
The Alaska Fish and Wildlife Research Center (Center) was established in 1986 after staff previously with the Alaska Office of Fish and Wildlife Research united with employees from two other research centers who were stationed in Alaska. The Alaska Center is one of 13 research centers in the nation that conducts and coordinates research for the Fish and Wildlife Service (Service). It is the only center that conducts both fishery and wildlife research. The staff is organized in four branches: Terrestrial Mammals and Advanced Technology, Marine Mammals and Fisheries, Migratory Birds, and Administration. In Fiscal Year (FY) 1992, we employed 40 permanent and up to 46 temporary staff.

The Center conducts most of its research on national wildlife refuges in Alaska. However, much of our research is also international in scope. Our biologists conduct cooperative research activities on shared migratory bird populations in Mexico and Russia. Additionally, several research projects include scientific exchanges with Russia. These cooperative agreements eliminate barriers to effective research and management of marine mammals, migratory birds, and Pacific salmon. We exchange scientists, aircraft and ship support, and biological data routinely with Russian agencies. The two countries also exchange contemporary technology related to the use of satellite imagery to identify habitat requirements

The Center is internationally known for its expertise and research projects in these areas:

- *Marine Mammals*: ecology of Pacific walrus, polar bear, and sea otter; population ecology and modeling; oil pollution damage assessment;
- *Terrestrial Mammals*: ecology of brown bear, caribou, muskox, and arctic and red foxes;
- *Contemporary Technology*: applications of satellite telemetry, geographical information systems, and DNA analysis to study arctic and subarctic fish and wildlife resources;
- *Migratory Birds*: ecology of waterfowl, seabirds, shorebirds, neotropical migrants, and raptors; wetland ecology; population ecology and modeling; oil pollution damage assessment;
- *Pacific Salmon*: ecology and genetic stock identification; and
- Identification and resolution of conflicts between wildlife and human's competing uses of Alaska's natural resources.

and movement patterns of wildlife, such as polar bears, Pacific walruses, and snow geese, that do not recognize political boundaries.



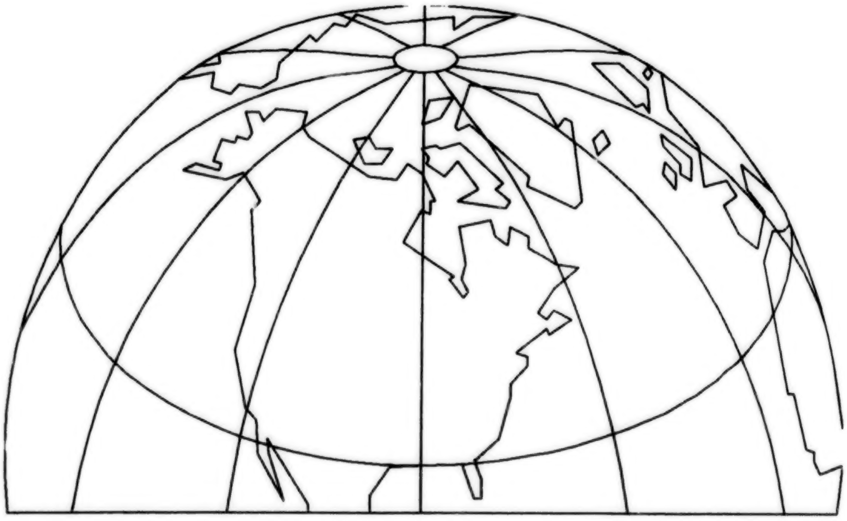
The Center budget for FY 1992. Funding codes: 1261 — refuge operations; 1411 — wildlife research; 1412 — fishery research; 1415 — maintenance; 1420 — technical development; 2831 — headquarters administration; 5100 — federal aid; 6320/6330 — oil spill; R7 — Congressional add-ons from Region 7 USFWS; REIMB — 1971, 1977 reimbursable funds from other federal agencies. BASE refers to multi-year funding, ADD-ON refers to 1-year funding.

Funding in the Center in FY 1992 was $6,476,101 including $136,946 in reimbursable funds from other federal agencies (1971 and 1977 accounts; see table), $706,730 in oil spill damage assessment funds (accounts 6320 and 6330), and $249,000 from various Congressional add-ons to the Service's Alaska Region (Region 7) to support migratory bird research in western Alaska. A major portion (83%) of the Center's base funding came from the Wildlife Research account (1411). Nearly 38% of this account supports research in the Migratory Bird Branch. Funds from the 1411 account for Marine Mammals (25%) and Terrestrial Mammals and Advanced Technology (25%) were split evenly. Over 11% ($485,000 in the 1412 account) of the Center's base supports our fishery research program. Base funding for our new research starts in global climate change totaled $237,000 (1420). Refuge operations (1261) provided $658,000 in support of research on migratory birds and terrestrial and marine mammals.

Center staff work closely with Region 7. Researchers from the Center and operational staff from Region 7 worked together to assess impacts of crude oil on the wildlife resource in Prince William Sound and the Kenai Peninsula in the aftermath of the *Exxon Valdez* oil spill. The Center and Region 7 exhibit the same high level of cooperation in the ongoing baseline studies of wildlife and their habitat in the Arctic National Wildlife Refuge (NWR), waterfowl studies on the Yukon Delta and Yukon Flats NWR, and fishery studies on Kenai NWR.

Our research activities address several issues unique to the Service. Field—rather than laboratory—projects dominate Center activities. However, ongoing laboratory studies use protein electrophoresis and DNA analysis for genetic stock identification of Pacific salmon, migratory bird, and marine mammal populations. Field work in Alaska often takes biologists to remote areas for prolonged periods. Harsh environmental conditions and the extreme seasons of the arctic often restrict the methods and timing of research projects. Customs of Native groups throughout the state also influence when, where, and how research is conducted. Projects often involve cooperative efforts with Native peoples to study fish and wildlife resources.

Annually there is strong pressure to develop the vast natural resources. Many of the Service's efforts are focused on reducing and mitigating the harmful impacts of these development projects on fish and wildlife populations. The results of our research projects provide the badly needed factual information Service managers need to address these impacts. For many of the bird, mammal, and fish species we study, little is known about their geographic distribution, the size of their populations, or even basic life history parameters. Thus, much of the work involves compiling basic facts about poorly known species, such as the buff-breasted sandpipers and spectacled eiders, in isolated regions of Alaska.



MAMMALS

Terrestrial and marine mammals in Alaska have high public visibility as demonstrated by the widespread concern for sea otters in the Exxon Valdez oil spill in Prince William Sound and caribou in the coastal plain of the Arctic National Wildlife Refuge. The three species of marine mammals for which the Service has management responsibility (polar bear, Pacific walrus, and sea otter) are in demand for subsistence by Native Alaskans. The large terrestrial mammals (brown bear, caribou, and muskox) we study are in demand for sport hunting and subsistence uses. Management of these animals is enhanced through research about their life histories and the development of contemporary technologies such as satellite telemetry, geographical information systems, and DNA analysis.

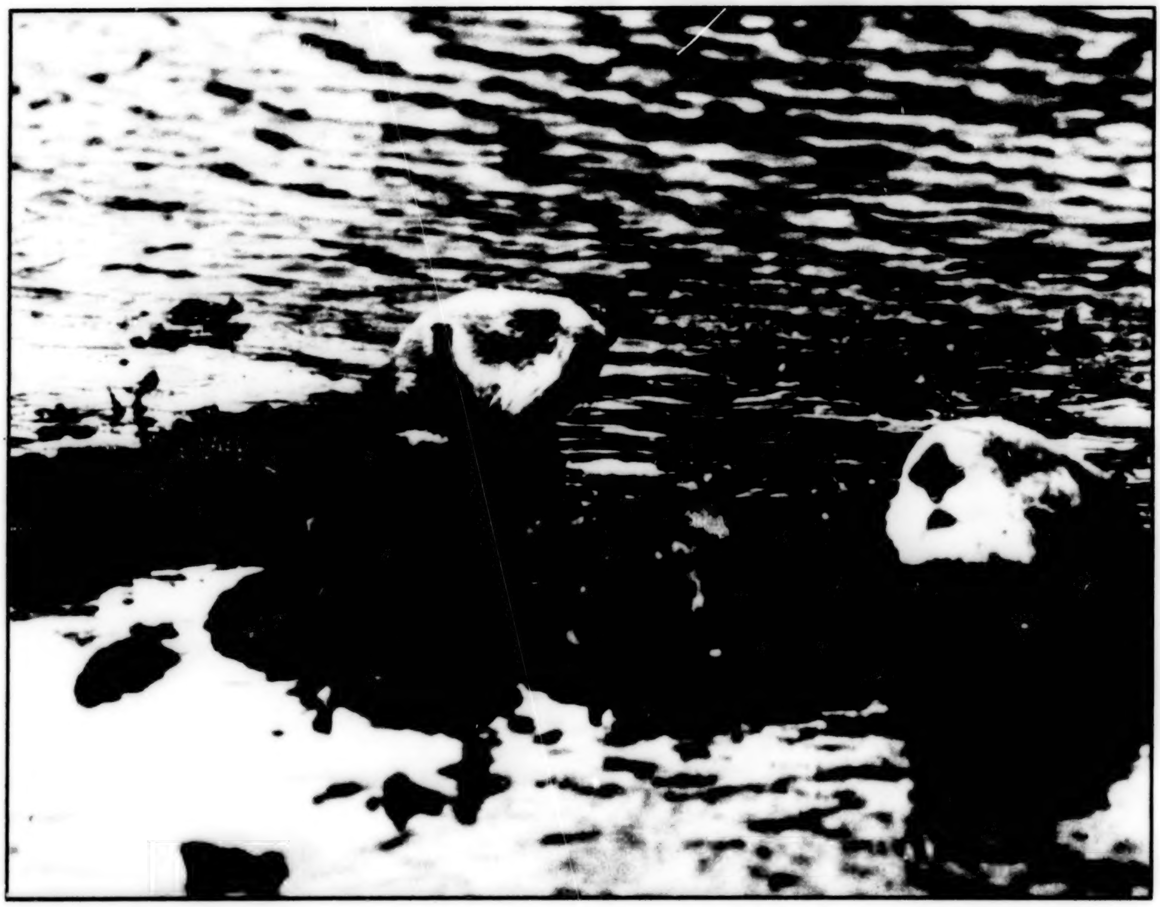
The *Exxon Valdez* Oil Spill

On March 24, 1989, the *Exxon Valdez* ran aground in Prince William Sound and resulted in the largest spill in U.S. history. The Center responded quickly with help and advice as well as by diverting staff and funding from some of its ongoing research projects to assess the damage and potential impacts on wildlife in the areas affected by the spill. Shortly after the spill, the Center initiated a number of studies to assess the effects of the spill on the sea otter population in the spill area. Until recently we have been unable to report the results of these studies because the Department of Justice declared them to be litigation sensitive. In 1992, the lawsuit between Exxon and the Federal Government was settled and the findings of our studies can now be reported.

Effects of the *Exxon Valdez* Oil Spill on Sea Otters in Prince William Sound

Sea otters are widespread throughout Prince William Sound (PWS) and were severely damaged as a result of the *Exxon Valdez* oil spill (EVOS). They rely on their fur to keep them warm, and consequently were particularly vulnerable to oiling which destroyed the fur's insulative value. Otters ingested large amounts of oil as they attempted to clean their fur by grooming. Carcasses of 781 sea otters that were judged to have died because of the EVOS were recovered in or adjacent to the oil spill area, with 424 of those from PWS. An additional 123 otters died at rehabilitation centers. More sea otters were undoubtedly oiled and died, but their carcasses were not recovered. Biologists estimate that total sea otter mortality in PWS was over 2,000, and that, in the entire spill area, mortality may have exceeded 4,000. There was a high incidence of pulmonary emphysema and gastric erosion and hemorrhage, in addition to kidney and liver damage.

An unusually high proportion of prime-age adults died in both the spill year and in post-spill years relative to pre-spill



Sea otters are widely distributed in Prince William Sound. Biologists estimate that nearly 2,000 otters died in the Sound as a result of the Exxon Valdez oil spill. Mortality may have exceeded 4,000 in the entire spill area.

years. Before the spill, mortality was highest in juveniles (45%) and aged (40%) individuals, and relatively low (15%) in prime-age adults.

Following the spill and continuing through 1991, mortality of prime-age adults increased to 43-44%. This suggests that there are prolonged, spill-related effects on the sea otter population as a result of the EVOS. Survival of weanling sea otters since the spill has been significantly lower in the oiled area (13%) than in an unoiled area (36%). Pre-spill and post-spill boat-based surveys indicated that between 1984-1985 and 1989-1990, sea otter abundance increased 13% in unoiled areas compared to a 35% decrease in oiled areas. By 1991, otter abundance in oiled areas had apparently stabilized, but was still below pre-spill levels.

Recovery of Sea Otter Carcasses Following the *Exxon Valdez* Oil Spill

Sea otter carcasses were recovered in or adjacent to the oil spill area between March 30 and September 15, 1989. Investigators subjectively scored carcasses in suitable condition by relative degree of external oiling and extent of decomposition; and recorded weight, length, general age class (adult, subadult

Over 870 sea otter carcasses were recovered in the aftermath of the Exxon Valdez oil spill, 474 in Prince William Sound alone. Adults comprised 58% of the carcasses from the Sound. Nearly 93% of the carcasses from the Sound were oiled.

or pup) and reproductive condition (including presence or absence of lactation). They also removed reproductive tracts to determine reproductive history. Complete necropsies were performed on 214 suitable carcasses.

Eight hundred and seventy-one sea otter carcasses were collected during response activities, and 123 live otters were captured and subsequently died at rehabilitation centers. Ninety of the recovered carcasses were judged to have died prior to the spill. One hundred and twenty of the carcasses were not evaluated as to time of death relative to the spill and were included in the analyses. The remainder (904) reflects a minimum estimate of acute sea otter mortality. It is almost certain that additional sea otters were oiled and subsequently died and their carcasses not recovered.

Four hundred and twenty-four carcasses were recovered from Prince William Sound (PWS), 167 from the Kenai Peninsula (KP), and 190 from the Kodiak Island/Alaska Peninsula (K/AP) area. The proportions of otters which apparently died before the spill were estimated at 15%, 9% and 5% for PWS, KP and K/AP, respectively.

The proportions of oiled carcasses and the degree of oiling (heavy, moderate, light or none) generally declined as the distance from the spill increased. Percentages of oiled carcasses for the three areas were 93%, 68%, and 52%, for PWS, KP and K/AP, respectively. Heavily and moderately oiled carcasses were 67%, 48% and 30% from the three areas, respectively. The proportion of lightly oiled carcasses was relatively stable at 26%, 20%, and 24%, respectively. The condition of carcasses was similar among the three recovery areas.

Adults comprised 58%, 57% and 33%, subadults 33%, 13% and 10%, and pups 9%, 30% and 57% of the carcasses from PWS, KP and K/AP, respectively. Of the adults, the proportion of females was 67% and 65% from PWS and the KP, respectively. From the K/AP region, the numbers of adult males and females recovered were approximately equal (48% female). We found 62% of the female carcasses from PWS pregnant and 15% lactating. At Kenai, 30% were pregnant and 33% lactating.

Service biologists conducted two experiments to evaluate the carcass recovery efforts. They found that a small proportion (2 of 30) simulated carcasses left PWS. Biologists released 25 marked sea otter carcasses near northern Kodiak Island in an area where wildlife rescue and beach clean-up crews were operating. Five of the 25 carcasses (20%) were recovered. Similar rates have been obtained from similar studies in California. Assuming the results of this experiment are applicable to the overall spill area, the loss estimate associated with the oil spill would be 4,028. This loss estimate should be used with caution because biologists have little knowledge to test the assumptions underlining the estimate. Current estimates have not accounted for the loss of reproductive potential from the sea otter population associated with females pregnant at the time of death.

Age Distributions of Sea Otters Dying in Prince William Sound after the *Exxon Valdez* Oil Spill

Opportunities to collect fresh carcasses of dead sea otters with known oil exposure histories are rarely available. The *Exxon Valdez* oil spill (EVOS) provided such an opportunity to look for effects at the population level. Generally, carcass recovery rates of marine mammals and seabirds are not useful in estimating mortality rates. However, systematic surveys for beach-cast carcasses can provide useful information on temporal patterns of mortality and on the age class structure of the dying portion of the sea otter population under study. Studies of sea otter populations in California; Amchitka, Alaska; and Prince William Sound (PWS) show a general pattern of the age class structure of sea otters dying in a population experiencing natural mortality: a bimodal age distribution with the first mode consisting of young animals and the second mode consisting of aged animals. The proportion of prime-age (2-8 years) sea otters is relatively low.

Age distribution of sea otters dying in western PWS (WPWS) in 1990 and 1991 allows a comparison against an expected mortality pattern. A change in the age class structure from the general pattern described above may indicate abnormal mortality representative of continuing deleterious effects of oil exposure.

Age was determined for 142 sea otter carcasses recovered in PWS pre-spill. Of these, 45% were from juveniles (0 or 1 year of age), 15% from prime-age and 40% from aged adult (9 years or older) sea otters. Age was determined for 437 carcasses recovered in WPWS: 32% was from juveniles, 44% from prime-age and 24% from aged otters. Sixty-six carcasses recovered at Green Island and other areas of western PWS in 1990 and 1991 revealed that 33% were juvenile, 43% were prime-age, and 24% aged. The proportion of prime-age carcasses recovered increased in both the spill year and in post-spill years, relative to the pre-spill years. Differences between pre-spill and spill year age distributions, and between pre- and post-spill age distributions were statistically significant. There were no significant differences between spill year and post-spill years.

The age distribution of sea otters dying in WPWS represents a shift in the age-class composition of sea otters dying in WPWS from a pre-spill, bimodal distribution, composed of primarily young and old animals, to an increased proportion of prime-age animals in years following the oil spill. This shift suggests that higher than normal proportions of prime-age sea otters are dying in some portions of PWS, and may be evidence of a prolonged, spill-related effect on the sea otter population affected by the EVOS.

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Evidence of Trends in the Pacific Walrus Population

Pacific walruses are distributed over a large area in the Bering and Chukchi seas. Biologists have used aerial surveys as the primary method of assessing the status of the population since the first survey in 1958. However, aerial surveys produce variable and biased population estimates. Population estimates are needed, rather than an index or relative abundance, so managers in Russia can set harvest limits and managers in the U.S. can comply with the requirement of the Marine Mammal Protection Act that the population be maintained within the range of the Optimum Sustainable Population range. Managers also need the trend of the population size and a measure of the status of the population relative to current carrying capacity.

Since 1986, Center biologists and

cooperators from the University of Maine have conducted a research project aimed at development of techniques for population assessment of Pacific walruses. One of the studies addressed the evidence of trends in the Pacific walrus population.

Detection of trends over time in the number of walruses depends on the rate of change to be detected, the number of surveys, the variability of the population estimates and the degree of confidence desired. For walruses, the variability of population estimates is large, the rate of change of the population is likely to be small, and surveys are infrequent because they are expensive and difficult to coordinate.

These factors lead to a high degree of risk of statistically failing to detect a trend (decrease or increase) in the population, even though the population was in fact decreasing or increasing. Conversely, even though a plot of the point estimates of the population might look as though a trend was present, when

Pacific walruses are found over a large area in the Bering and Chukchi seas. Since 1958, aerial surveys have been the primary method of assessing the status of the population. Areas on several of Alaska's National Wildlife Refuges are important haulout areas. How many are in this picture? (See text for the answer.)

the uncertainty associated with those numbers is taken into account, the presence of a trend cannot be ascertained. For example, with a coefficient of variation of 0.6 (relatively optimistic given the current methods), a 5-year interval between surveys, a population declining at 5%/year, the levels of Type I and Type II errors equaling 0.1, it would take 13 surveys over 60 years to detect the change statistically.

When the additional variance due to the proportion of the population that is not seen during the survey is incorporated, the number of surveys needed to detect a trend is increased. The current methods of population estimation are not adequate to detect a trend in the walrus population with sufficient power to be relied upon for management decisions.

Because aerial survey methods are of limited use in the management of walruses, additional sources of information are needed. For example, properly validated multiple indices, such as pregnancy rate, proportion of calves, or age at first reproduction, may indicate the relation of the population to the carrying capacity of the environment. A change in indices of density dependence could be due to a change in the carrying capacity of the environment rather than a change in the numbers of walruses, so some measure of population size is still necessary, as well as to comply with legal requirements of the Marine Mammal Protection Act. The population should continue to be estimated from aerial surveys if the variance in the population estimates can be reduced through further changes in methods, such as stratification on habitat or additional data about haulout patterns and synchrony. *(Quiz answer: 1,023 walruses in aerial photograph on page 9.)*

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Polar Bear Maternity Denning in the Beaufort Sea

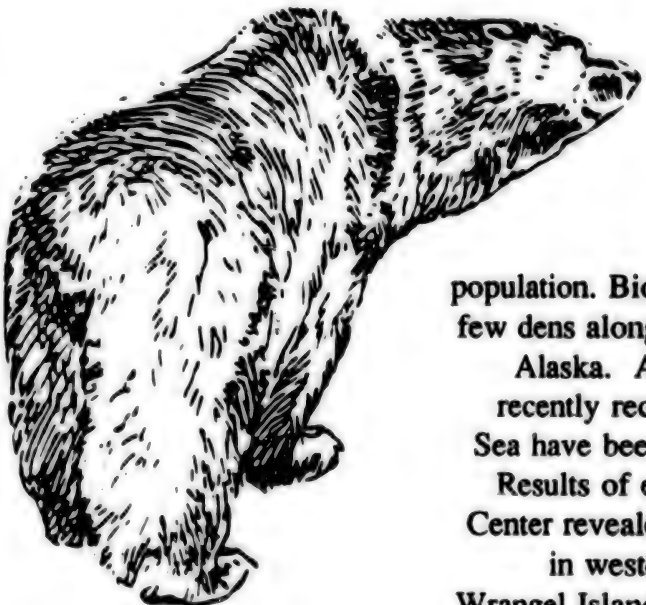
The distribution of polar bears is circumpolar in the northern hemisphere, but known locations of maternal dens where they give birth are concentrated in relatively few widely scattered locations. Denning is either uncommon or unknown within gaps between known denning concentration areas. The Beaufort Sea region of Alaska and Canada lies in the largest of those gaps. Early bear investigations suggested that bears living in this area are produced elsewhere. As many as 2,000 polar bears occur in the Beaufort Sea year around, and at least 140 females should seek dens there each fall. Yet, 11 years of study, plus analysis of historic sightings dating to 1910, revealed locations of only 35 dens. Early bear biologists felt denning habitat along Alaska's north coast was limited.

In 1981 the Center initiated polar bear investigations on the Beaufort Sea. Between 1981 and 1991, we captured and radio collared polar bears and verified that denning in the Beaufort Sea region was sufficient to account for the estimated population there. Between 1981 and 1985 we attached very high frequency (VHF) radio collars to bears and relocated them with aircraft. After autumn 1985, we mostly deployed ultra high frequency (UHF) transmitters that were relocated by satellite.

Fifty-three percent of 90 dens were on drifting pack ice, 42% were on land and 4% on land-fast ice. The proportion of dens on land was higher in later years of our study. Bears denning on pack ice drifted as far as 997 km (mean of 389 km) while in dens. Differences in production of land and pack ice dens were not detected.

Mean entry and exit dates were November 11 and April 5 for land dens and November 22 and March 26 for pack ice dens. Polar bear dens were of ice and snow only. Female polar bears captured in the Beaufort Sea appeared to be isolated from those occurring east of Cape Bathurst in Canada. Movements to den sites west of the Beaufort Sea were more common, but bears captured in the Beaufort Sea seldom denned in Russia.

Of polar bears that denned along the mainland coast of Alaska and Canada, 80% denned between 137 and 146 west longitude. Bears we followed to more than one den did not reuse sites and consecutive dens were 20-1,304 km apart, but radio-collared bears were largely faithful to the substrate and the general geographic area of previous dens.



Most bears that denned on land selected sites in the northeastern corner of Alaska or adjacent Canada where oil and gas exploration has occurred or is likely. Bears denning on land may be vulnerable to human activities like hunting and industrial development. However, their predictable chronology and absence of site fidelity indicate that many potential impacts on denning polar bears could be mitigated.

Cooperative U.S./Russia Polar Bear Research Continues to Provide Valuable Biological Information

Wrangel Island in the eastern Russian arctic is an important denning concentration area for maternal polar bears. Early bear researchers proposed that the polar bear population of western Alaska was shared with Russia and later indicated that the movement patterns of females that den on Wrangel Island were important in determining the population ecology of the Chukchi Sea population. Biologists have recorded few dens along the western coast of Alaska. A majority of the dens recently recorded in the Beaufort Sea have been on drifting sea ice. Results of earlier research by the Center revealed that bears captured in western Alaska denned on Wrangel Island and documented the international nature of the bear population.

A cooperative U.S./Russia polar bear research program was initiated in 1989, and U.S. and Russian scientists conducted a capture program of females emerging from maternity dens on Wrangel Island during spring 1990 and 1991. Results of the 1990 effort are summarized here. Biologists captured 22 adult female polar bears and 39 accompanying cubs-of-the-year between March 26 and April 2, 1990. They also captured one non-lactating female and one lactating female not accompanied by cubs-of-the-year. Average litter size of 20 family groups captured was 1.96 cubs. All adult females were fitted with satellite collars.

Movements during the following year indicated no subsequent geographic segregation in the Chukchi or East Siberian seas of females that denned in various regions of Wrangel Island. Movements encompassed the eastern half of the East Siberian Sea, the entire Chukchi Sea, extreme western portions of the Beaufort Sea, and portions of the Bering Sea lying north of Saint Matthew Island. One third of the marked females over-wintered in the active sea-ice shear zone, which lies along the northern shoreline of the Chukotka Peninsula in Russian territory. Unlike polar bears in Hudson Bay that become stranded on land during summer, most polar bears in the Chukchi Sea remain on sea ice throughout the year.

The broad geographic area occupied by polar bears of the Bering and Chukchi seas, the seasonal diversity and dynamic nature of the sea-ice habitat, and the remoteness of the area present challenges to studies using traditional methods. We will continue to work closely with the Russians to meet these challenges.

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Deer Hunters Interact with Brown Bears on Kodiak Island

Brown bears on Kodiak Island occur at high densities. The population appears healthy primarily because forage is abundant, sport harvest is intensively managed, and there are large tracts of remote and inaccessible habitat. About two-thirds of the island is under land management of the Kodiak National Wildlife Refuge. The refuge's primary management goal is conserving brown bears and their habitat. The refuge also accommodates seasonally high concentrations of people engaged in hunting, fishing, or other recreational activities. Levels of human activity have risen sharply in recent years, a trend expected to continue in the foreseeable future. Development of guidelines for managers to effectively minimize conflicts requires an improved understanding of bear/human interactions associated with specific recreational activities such as deer hunting. Sitka black-tailed deer hunting is a relatively new recreational pursuit on Kodiak and adjacent islands. Deer were introduced to the island group in 1924 and had become common to abundant in most areas by the late 1970's. A dramatic escalation in deer hunter effort paralleled rapid growth and expansion of the deer population. Conflicts between bears and hunters became inevitable as increasing

A study of brown bears on Kodiak Island is assessing the effects of deer hunting on the range and movement patterns of the bears and evaluating real or potential interactions between bears and deer hunters.

numbers of hunters encroached on habitat occupied by bears and because the activity created new sources of food attractive to bears. By the mid-1980's deer hunters had become the leading cause of defense of life or property (DLP) kills.

The Center in cooperation with the refuge and the Alaska Department of Fish and Game initiated a study in 1988 to assess effects of deer hunting activity on range and movement patterns of brown bears and to evaluate real or potential interaction between deer hunters and bears. Our efforts focused on the west side of Kodiak Island.

In our study area, the mean number of bears that annually ranged less than 5 km from the coast was 10; greater than or equal to 5 km, 8; and in both areas, 11. Bears that exclusively or seasonally occupied the coastal zone were usually classed as having moderate or high potential to interact with hunters because most hunter access and effort was via the coast. Bears that ranged exclusively inland were considered unlikely to encounter hunters. Females that denned near the coast entered dens later (mean around November 22) than females that denned inland (mean around November 12).

Deer hunter surveys revealed that over two-thirds of the deer harvest occurred during October-November. About half of the hunters observed at least one bear during their hunt. Seven to 21% of the respondents reported having a threatening encounter with a bear and 5-26% reported losing deer meat to bears. Human-induced mortality to radio-collared bears occurred more often near the coast (5) than inland (3); 7 bears were harvested by sport hunters and one was killed in a Native village. Deer hunters killed two unmarked females in DLP situations in the study area.

Concern for the impact of deer hunting on brown bears has prompted suggestions to reduce the sport harvest of bears in specific areas of Kodiak Island, reduce deer bag limits, or close deer season during certain time periods. Current information indicates these management options are not warranted at this time. Adverse impacts to bears can be minimized by maintaining low levels of human activity in inland areas and improving hunter awareness of bear ecology and behavior.

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Weight Gain of Caribou Calves Used to Rank Habitat Value

The coastal plain of the Arctic National Wildlife Refuge (ANWR) in northeast Alaska is the primary calving ground for the Porcupine caribou herd (PCH). Caribou of the PCH typically winter in the Yukon Territory and in Alaska south of the Brooks Range, but calve on the arctic coastal plain, north of the Brooks Range. Approximately 6-8 weeks after calving, they leave the coastal plain for mountainous areas in Alaska and in the Yukon Territory while en route to winter ranges.

Portions of the calving ground overlay the 1002 area—a potentially significant petroleum reserve. Identification of relatively high value habitats for calving caribou is necessary to mitigate potential disturbance to the PCH in the event of petroleum development. For terrestrial vertebrates such as mule deer and elk, biologists typically conduct use/availability studies to identify high value habitats. The biologists assume that when an animal selects habitats, those selections convey some fitness value (for example, survival or fecundity) to the subject animal. Unfortunately, this assumption is seldom, if ever, tested.

We designed our research to avoid having to make this assumption by directly estimating the relationship between weight gain of caribou calves (an index of fitness) and proportional use of different habitat types. Previous research on other species showed weight gain of offspring positively correlated with ungulate survival.

In early June 1992, we captured 80 newborn caribou calves by hand then weighed them and fitted each with a radio collar. Approximately 3 weeks later, 62 of these calves were recaptured with a netgun, reweighed, and released. About 6 weeks after initial capture, 12 of the calves were recaptured a second time with a netgun, reweighed, and released.

Between weighings, we obtained estimates of habitat use by individual calves with aerial radio-telemetry at an average frequency of three relocations per 4 days.

Calves weighed an average of 6.3 kg at initial capture, 15.1 kg at the end of 3 weeks, and 20.9 kg at the end of 6 weeks. Average daily gain was greater during the 0-3 week period than during the 3-6 week period. Calves shifted their habitat use more toward vegetation in low-centered polygons and away from non-patterned sedge and vegetation in high-centered polygons during the 3-6 week period.

Weight gain was related to habitat use. Based on positive, neutral, or negative relationships between daily gain and proportional habitat use, we ranked habitat value as high, medium, or low, respectively. In the 0-3-week period, tussock tundra vegetation had low value and other habitats had medium value. In the 3-6 week period, partially vegetated and riparian areas had high value, high-centered polygon vegetation had low value, and the remaining types (low-centered polygon vegetation, non-patterned sedge, and other uncommon or mountainous types) had medium value.

In 1992 biologists captured 80 newborn caribou calves by hand on the coastal plain of the Arctic National Wildlife Refuge in northeast Alaska. Each calf was weighed and fitted with a radio collar for later relocation. Calves weighed an average of 6.3 kg at initial capture and nearly 15 kg 3 weeks later. Weight gain was related to habitat use.

Preliminary results indicate that daily weight gain of calves as related to habitat use appears to have utility in identifying relative value of habitats on the PCH calving grounds. Habitat use, daily gain, and the relationship between these two attributes of caribou calves change over such a short time interval that it is unlikely we could have identified selected habitats with traditional use/availability analyses. The short term dynamics of habitat use and relative value during caribou occupancy of the arctic coastal plain suggest that potential mitigation measures may have to be time specific. Over the next 3 years we will address among-year variability in which habitats have high value, test the hypothesis that selected habitats confer fitness advantage, and characterize the nutritional properties of habitats that are associated with various levels of weight gain.

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Selected Areas in the Arctic National Wildlife Refuge Provide Relief from Insect Harassment to the Porcupine Caribou Herd during Calving and Post-Calving Periods

In 1992, the U.S. Congress considered legislation to open a portion of the coastal plain of the Arctic National Wildlife Refuge (ANWR) known as the "1002 area" to oil and gas development. Biologists and resource managers recognize the coastal plain portion of ANWR in northeastern Alaska as important calving and post-calving habitat for caribou that comprise the Porcupine caribou herd (PCH). After calving in June, caribou of the PCH form aggregations of up to 90,000 animals, probably to reduce harassment by mosquitoes. Harassment of female caribou by insects may negatively affect the cows' energy balance during the critical post-calving and lactation period.

The central Arctic herd (CAH) and PCH both use coastal areas to gain relief from insects; therefore, biologists have suggested a "no development" zone along the coast in the 1002 area as a potential mitigation measure for the PCH. To investigate the necessity of such a zone, the Center examined the PCH's use of coastal areas during predicted insect harassment. We identified probable insect relief habitats for the PCH by determining whether caribou prefer certain vegetation types during periods of predicted insect harassment. Also, we examined movement patterns of PCH caribou during predicted periods of mosquito harassment and determined whether individual caribou showed fidelity to insect relief areas within certain physiographic regions.

When insect harassment was predicted [ambient temperatures greater than or equal to 13 C and winds less than 6 meters/sec (13.4 miles/hour)], caribou used dry prostrate dwarf scrub vegetation on ridgetops in the foothills and mountains of the Brooks Range and on elevated sites of the coastal plain, as well as areas adjacent to the Beaufort Sea coast to gain relief from mosquitoes. PCH caribou did not show a strong tendency to move to the coastline at the onset of predicted harassment. Once harassment began their movements were significantly directional and often oriented into the wind. However, observations of animals during survey flights indicated that segments of the herd often follow the coastline while moving across the coastal plain of ANWR in July.

Our information suggests that mitigation measures cannot focus only on coastal areas when addressing concerns regarding insect relief habitat. Adequate mitigation of development activities will require information about the interaction between foraging opportunities, mosquito densities, predation risk at potential relief sites, and the consequences to the population if access to some relief sites is restricted.

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Satellite Imagery Allows Biologists to Monitor Seasonal Habitat Changes

The Center is investigating how seasonal variations of climate and vegetation phenology affect the distribution and migratory behavior of arctic wildlife such as caribou. Satellite images are providing the data necessary to cost-effectively quantify habitat conditions across broad landscapes at frequent time intervals.

The Advanced Very High Resolution Radiometers (AVHRR), carried aboard two National Oceanic and Atmospheric Administration satellites, scan the entire earth on a daily basis. The AVHRR images are continuously relayed to earth ground-stations, and the data are made available to a diverse community of scientists including oceanographers, meteorologists and biologists. The scientists use computers to analyze the images and create maps depicting a variety of environmental conditions including surface temperatures, photosynthetically active vegetation, snow cover, forest fires, floods, storm fronts, and sea ice distribution.

In northern latitudes, seasonal and climatic events play an important role in determining the quantity and quality of wildlife habitats. AVHRR satellite data provide biologists a tool for monitoring habitat conditions, especially during critical periods of migration and breeding. Current research has focused on the importance of snow cover in determining the quantity and quality of forage habitats available to the Porcupine caribou herd during its spring calving season on the arctic coastal plain of Arctic National Wildlife Refuge. Other pilot studies are investigating the application of AVHRR data to monitor the seasonal conditions of important waterfowl nesting areas. In the climatically distinct and diverse arctic environment, biologists and managers will benefit with an improved understanding of seasonal habitat variability and its importance to wildlife population dynamics.

MIGRATORY BIRDS

The wetlands, coastal shorelines and islands of Alaska provide habitat for millions of breeding seabirds, shorebirds and waterfowl. Large tracts of near-pristine habitat provide nesting habitat for over 73 species of passerine birds, including 28 species that migrate to the neotropics. Seabird populations appear to be at satisfactory levels, but several species of ducks and geese are at or near historic low. The Center is committed to research into effective means for managing these populations during an era of increasing commercial fishing, subsistence and sport hunting and fishing, natural resource development, and urban expansion.

Neotropical Passerine Bird Populations in Alaska

In 1992, the Center started a new multi-year effort to investigate the status and biodiversity of neotropical passerine bird populations in Alaska. Over the last 20-40 years, North American populations of many migratory neotropical bird species have declined. Alaska supports nesting populations of 73 species of passerine birds, including 28 species that migrate to the neotropics. Biologists believe the large tracts of near-pristine habitat in Alaska under federal and state jurisdiction may provide a source of production critical for the continued survival of passerine species in North America. Basic information on abundance, distribution, habitat use, survivorship, and annual production of passerines nesting in Alaska is virtually nonexistent.

Our research program includes the design and establishment of a cooperative, interagency program for monitoring long-term population trends of passerine birds on unfragmented, protected nesting areas on federal lands in Alaska, an analysis of existing data on historical abundance of neotropical passerine birds nesting in Alaska, development and testing of a model to relate the effects of wintering and breeding ground events on the status of North American passerine populations, and determination of the importance of Alaska habitats in preserving biodiverstiy among passerine populations in Alaska.

We initiated a small-scale research project that addressed census methodology for monitoring passerine populations in Alaska. Our biologists replicated point counts of birds over 10-day periods from early June to late July in the Anchorage area. There was a significant decline in the total number of species and total number of individuals recorded around July 10. Spring was late in the Anchorage area with definite waves of early and late migrants. The seasonal decline in detectability would likely occur earlier in the season during years with earlier springs. Because of this, we recommend that most point counts at the Anchorage latitude (61° N) should be conducted no later than the end of June.

We also replicated experimental point counts over 2-hour blocks of time after sunrise to examine diurnal variation in detectability. Preliminary analysis showed that there was significant decline in both number of species and number of individuals during the 10:30 a.m. to 12:30 p.m. block, followed by an increase in early afternoon. We recommend that counts at the Anchorage latitude be completed by 8:30 a.m. to avoid biases due to time of day.

Unlike point counts conducted in the lower 48 states, there was no significant variability among the three trained observers that conducted point counts. We feel that the relatively low densities of songbirds that breed at Alaska latitudes, the relatively few number of species that need to be recognized in any given region of the state, and potential effectiveness of training programs minimized the variability.

Rare Sandpiper Breeds in the Prudhoe Bay Oil Field

In 1992, the Center, in cooperation with BP Exploration (Alaska), Inc., initiated a 3-year study to investigate the breeding behavior and habitat use of the buff-breasted sandpiper in the Prudhoe Bay Oil Field (PBOF) on the north slope of Alaska. This study is part of the Center's ongoing shorebird research program. This species breeds sporadically along the arctic coastal plain of Alaska and western Canada, and in a few isolated areas of Russia. The current size of the buff-breasted sandpiper population is unknown, although it is reported to be rare throughout its breeding range. A central goal of our study is to determine habitat requirements of this relatively rare shorebird, and to ascertain whether existing oil

A new Center study addresses the breeding behavior and habitat use of the buff-breasted sandpiper in the Prudhoe Bay oil field on the north slope of Alaska. This sandpiper breeds sporadically along the arctic coastal plain of Alaska and western Canada, and in a few isolated areas of Russia. Preliminary evidence suggests that buff-breasted sandpipers do not establish leks (aggregations of males displaying to attract females) on man-created habitats such as abandoned gravel pads.

development at the PBOF has any positive or negative effects. Ultimately, we hope to develop a predictive model of habitat use that can be applied throughout the North Slope of Alaska.

Buff-breasted sandpipers have several features that make them unusual and difficult to study. First, it is the only North American shorebird that forms leks (aggregations of males displaying to attract females) for breeding. We know very little about the specific habitats in which leks are found, the size and location of leks, and the traditionality of birds to the leks. Previous studies suggest, however, that buff-breasted sandpipers may use man-created habitats such as abandoned gravel pads during this critical period. Second, the species has low breeding site fidelity and natal philopatry (that is, the tendency of the bird to stay in or return to its home area), and experiences large inter-annual population fluctuations. Monitoring this species is especially difficult, and alternative survey designs may be needed.

Biologists collected information on the location, size, and duration of male display on leks by conducting variable circular plot surveys on nine 4 km^2 study plots located throughout the PBOF. They also used radio-equipped birds to collect additional information on male display and female nesting and brood-rearing habitat requirements.

Contrary to their expectations, six of seven leks seen in a 2-week preliminary survey in 1991 had displaying males present in 1992. Breeding site fidelity may be higher than biologists previously believed. Males displayed on leks and in dispersed territories. The location of display areas appeared to be tied to the initiation of nests by females. Repeated visits to lek areas revealed that a single visit was inadequate to estimate the abundance of birds. There was an extremely high turnover rate on leks, suggesting that a single lek may be used by a large number of males, each for a short period of time. Repeated surveys may be needed to obtain reliable estimates of the number of birds in an area.

Lekking and dispersed males used different vegetation and landform types for display; lekking males used moist, non-patterned areas while dispersed males used dry, reticulate-patterned areas. Most leks were located adjacent to streams, suggesting that males may display here to attract females migrating up the stream corridors. Nests were found primarily in moist and wet vegetation, and in non-patterned landforms and raised linear ridges in the tundra. Preliminary evidence suggests that buff-breasted sandpipers do not establish leks on man-created habitats. However, field observations indicate that birds do not avoid these areas.

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Seabird Ecology in the Bering Strait

As gateway to three currents that flow from the Bering Sea to the Arctic Ocean, the Bering Strait creates a dynamic and productive marine environment that supports a world-class population of seabirds during summer. Of some 3.6

million birds that breed locally, 97% are in the Alcidae—a diverse family of diving seabirds that are adapted superbly for underwater pursuit of zooplankton and fish. The largest colonies in the region are centered in Bering Strait on Big and Little Diomede islands. Populations consist mostly (greater than 90%) of small, shallow-diving (10-25 m) auklets that forage on local concentrations of zooplankton. Least auklets specialize on calanoid copepods and amphipods, whereas crested auklets and parakeet auklets rely on larger plankton, especially euphausiids, mysids, and jellyfish.

Center biologists conducted seabird surveys in the Bering Strait between June 30 and July 14, 1991, from the Service vessel M/V Tiglax. They investigated the distribution of zooplankton and seabirds in relation to oceanography. Seabirds were counted at the sea surface on 302 standardized ship-board transects about 3 km in length. Zooplankton densities in various depth strata were

Advanced acoustical equipment aboard the Service's M/V Tiglax allows Center biologists to investigate the distribution of zooplankton and seabirds in relation to oceanography. Our biologists counted seabirds on the sea surface using standardized ship-board transects.

measured acoustically during 287 seabird transects.

Three distinct water masses flow north through Bering Strait. East of the Diomedes, Alaska Coastal Water (warm, low-salinity) sustains a low biomass of coastal zooplankton species, few planktivorus (plankton eating) seabirds, and moderate densities of piscivorous (fish eating) seabirds. South of the Diomedes, zooplankton and seabirds were scarce at the front between Alaska Coastal Water and Bering Shelf Water (cold, moderate salinity). Least auklets and oceanic copepods were abundant in stratified Shelf Water and near upwelled Anadyr Water (cold, high-salinity) in western Bering Strait. Southwest of the Diomedes, a small (20-30 km) baroclinic eddy [baroclinic (density driven) eddies are commonly generated in nuclear areas at the boundary of water masses with differing densities] surrounded by upwelled Anadyr Water contained the highest acoustically determined biomass of zooplankton in the study area. Crested auklets, which feed mostly on euphausiids, were associated with the eddy.

Piscivorous seabirds (murres, kittiwakes, puffins) foraged mostly in stratified Alaska and Siberian coastal waters, and were largely absent from central Bering Strait, except around the Diomede Islands. Biologists conclude that physical processes (upwelling, eddies, stratification) in Bering Strait determine zooplankton availability to planktivores. Auklets exhibited threshold responses to plankton density, and appeared to forage only so far from their colonies as was necessary to exploit dense, accessible plankton aggregations. Because of its central location, variety of habitats, and complex oceanography, the Diomede Islands themselves are an important foraging area for many seabird species.

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Reproductive Effort of Ducks in Subarctic Alaska is High

The relative importance of breeding duck populations in Alaska has increased as the number of breeding ducks in prairie regions of North America has declined. For example, in recent years more than 50% of all northern pintails on surveyed areas in North America have been counted in Alaska. Pintails are the most abundant ducks on Yukon Delta National Wildlife Refuge (NWR). Lesser scaups, pintails, and American wigeons are, in order, the three most abundant ducks on Yukon Flats National Wildlife Refuge (NWR). These refuges have the highest numbers of ducks in Alaska based on standardized breeding pair surveys. Despite the importance of these areas, no previous data were collected regarding duck productivity. Biologists from the Center, as part of ongoing studies of waterfowl reproductive physiology, measured the proportion of hens with evidence of at least one breeding attempt and the occurrence of renesting for lesser scaups, pintails and wigeons on these two important subarctic Alaskan areas.

Biologists collected hen pintails on the two Yukon River refuges in 1990 and 1991. In 1991, we collected lesser scaup and wigeon hens on Yukon Flats NWR.

We collected birds from arrival through incubation and renesting. Hens were assigned to breeding status categories based on ovary and brood patch characteristics. A high percentage of collected pintail hens was either arriving or showed evidence of breeding (95% on Yukon Flats and 97% on Yukon Delta). Also, many were renesters (16% on Yukon Flats and 28% on Yukon Delta). Similar percentages of lesser scaups and wigeons (93% and 94%, respectively) were classified as arriving or breeding. Renesting was also common; 23% of lesser scaups and 18% of wigeons had made more than one nest attempt.

Previous studies have reported that fewer mallard and pintail hens in the Canadian high arctic were in breeding condition than those in prairie breeding grounds. Others have demonstrated that ducks, particularly pintails, are displaced to Alaska when prairie conditions are poor and have suggested that they either have reduced production or do not breed at all. Our data demonstrate that assumptions of low breeding potential at high latitudes are not applicable to all areas in Alaska. We believe that these two refuges play an important role in maintaining continental duck populations.

In recent years biologists have counted more than 50% of all northern pintails on surveyed areas in North America. Pintails are the most abundant ducks on Yukon Delta National Wildlife Refuge (NWR). Our studies show that refuges like Yukon Delta and Yukon Flats NWR (pictured here) play an important role in maintaining continental duck populations.

Petroleum exploration and potential future development in areas such as the National Petroleum Reserve in northwestern Alaska include activities that may be detrimental to staging and molting brant and other birds. Center biologists, after studying responses of molting black brant to helicopter activity, recommended that helicopter flight schedules be adjusted during the brant molting season to minimize disturbance.

Model Allows Assessment of the Impact of Helicopter Disturbance to Molting Brant

The Naval Petroleum Reserves Production Act of 1976 transferred management of Naval Petroleum Reserve Number 4 in northwestern Alaska from the U.S. Navy to the Secretary of the Interior and renamed the reserve the National Petroleum Reserve in Alaska (NPR-A). The Bureau of Land Management manages the NPR-A and is responsible for conducting a petroleum leasing program while protecting fish and wildlife resources. The area surrounding Teshekpuk Lake in the NPR-A was designated a Special Area by the Secretary of the Interior in 1977 primarily because of its significant value to fish and wildlife resources.

Petroleum exploration and potential future development in NPR-A include activities that may be detrimental to staging and molting brant and other birds dependent on habitats in the Teshekpuk Lake Special Area (TLSA). Exploration on the Arctic Coastal Plain during the months of May through September usually requires aircraft support, particularly helicopters, for staging materials and transport of personnel. Helicopters are used to protect tundra habitats from damage that would occur if tracked and other ground vehicles were employed during the thaw period.

Center biologists and cooperators from Texas A&M University investigated the response of Pacific black brant to helicopter activity over a 5-year period beginning in 1987. The population of brant using the TLSA varied from 8,184 to 23,395. A mean of 13,317 brant, representing 10.4% (6.3 to 16.6%) of the total population, used the TLSA during the 5-year period. Biologists banded 5,589 brant. Band recoveries show that molting birds came from breeding colonies in Alaska and Canada. In addition, we recaptured brant that had been banded at a major molting area on Wrangel Island, Russia.

Despite planned schedules and commitments from aircraft support services for large helicopters, the only significant experimental results are for Bell 206 models. Data suggest that flights of smaller helicopters at mid-level altitudes were more disturbing to brant than at high or low levels. In general, flights over 1,070 m did not significantly disturb molting brant. In addition, there was a general trend toward reduced disturbance at greater lateral distances. Flock size was an important influence on flock response. Moreover, brant did not habituate to helicopters on a daily or seasonal basis.

Investigators developed a spatial model that allowed assessment of the impact of potential disturbance on brant populations. Longer routes disturb significantly fewer birds than the most direct routes commonly traveled on the area. Serious reductions in body weight were predicted at high travel frequencies of greater than 50 flights/day during the molt. In the absence of experimental data on overflights of Bell 212/412 helicopters, impacts of these larger models were simulated by using data from sound and disturbance studies at other sites. Based on the increased impact zones derived for this larger helicopter, their audibility is greater than the Bell 206 model, but the impact on the birds is only slightly increased because of brant distribution patterns on the lakes.

Implications of these studies for management of oil development in this region are clear: (1) The TLSA is unique and no other known area could replace this habitat for brant anywhere within the Alaskan Coastal Plain. (2) Disturbance by helicopters (and to a lesser degree, other aircraft) is serious and flight schedules must be adjusted during the brant molting season. (3) Restrictions would not be necessary for the entire summer. (4) Planes must fly higher during the molting period to reduce disturbance, preferably above 1,070 m. (5) If fog is present, our model suggests that use of alternate flight-lines to avoid major molting areas will greatly reduce weight losses.

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Northern Pintails in Alaska and Prairies Have Similar Mitochondrial DNA

Surveys indicate that the number of northern pintails breeding in North America is 62% below the long-term (35-year) average and continues to decline.

Numbers in the prairie pothole region declined dramatically, whereas counts in Alaska remained relatively stable, and in recent years accounted for 45-60% of the continental total. If there has been isolation among breeding populations, long-term geographic segregation may have resulted in genetic differentiation in birds from different breeding areas. If breeding populations can be genetically differentiated, this could provide a valuable tool for their identification and management. Geneticists at the Center are examining genetic variation by comparing mitochondrial DNA (mtDNA) of pintails within and among breeding areas in Alaska and the prairie pothole region of the United States and Canada.

MtDNA can be an indicator of female-mediated gene flow because it is maternally inherited in egg cytoplasm without sexual recombination. Center geneticists isolated mtDNA from blood taken from postbreeding pintails on a North Dakota national wildlife refuge (NWR) and Yukon Flats and Yukon Delta NWRs. We determined mtDNA genotypes using restriction enzyme fragment patterns obtained by Southern blot analysis.

Pintails showed abundant mtDNA variation. In this analysis there were no significant differences in genotype frequency among area. The co-occurrence of genotypes among breeding areas and lack of frequency differences suggest that there has been gene flow among areas or recent colonization from common source populations. The large number of genotypes is similar to that observed in other bird species. This suggests that large historical population sizes have resulted in the maintenance of many genotypes. Also, area-specific genotypes are all similar in nucleotide sequence divergence, indicating that all of the genotypes stem from a common maternal lineage within the last 10^5-10^6 years.

We are examining additional samples obtained from Alaska and new areas within the prairie pothole region to broaden the scope of the study, improve the resolution of our analysis of gene frequencies, and determine if rare genotypes are area-specific. Moreover, we are isolating mtDNA from pintail tissues obtained in California, Louisiana, Texas, and Mexico for preliminary analysis of wintering populations.

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Successful Performance of Satellite Transmitters Attached to Migrating Lesser Snow Geese

Two of the Service's research centers conducted the largest experimental avian satellite tracking study ever with the smallest mass-produced transmitters yet available. Preliminary results indicate that the lightweight transmitters will provide the long-awaited technology for avian migration studies. During 1991, the Northern Prairie Wildlife Research Center initiated a cooperative study with Nippon Telegraph and Telephone of Japan (NTT), the Alaska Center, and several biologists from Russia, Canada, and Pacific Flyway states to track the southward migration of Wrangel Island lesser snow geese by satellite telemetry. Primary objectives were to document the migration of lesser snow geese from

Service biologists attached lightweight satellite transmitters to lesser snow geese (pictured) on Wrangel Island, Russia, to track the southward migration to their wintering areas in northwestern Washington and central California. Two polar-orbiting NOAA satellites received the data transmitted from the birds.

Wrangel Island, Russia and test a 54-g ARGOS-certified satellite transmitter (PTT) recently developed by NTT.

Fifteen PTTs were adapted to modified backpack harnesses and another 14 were affixed to plastic neck collars. Total weight of each PTT and attachment averaged 85 g. The expected battery life for each PTT was 125 days. Biologists deployed the 29 PTTs on adult male lesser snow geese at Wrangel Island, Russia, in late July 1991. Two polar-orbiting NOAA satellites received the data transmitted from the birds.

Satellite tracking confirmed the movement of 21 geese from Wrangel Island to Alaska, and 9 were tracked to their wintering areas in northwestern Washington and central California. For the 9 PTTs that successfully reached the wintering areas, locations were obtained for an average of 116.7 days. A greater proportion of the PTTs attached to neck collars were successfully tracked to the wintering areas. PTTs attached to backpack harnesses recovered significantly more data than PTTs attached to neck collars. A superior line-of-sight orientation of the antenna to the satellite was achieved by the harness. In comparison, the antenna in the neck collar hung below the bird, interfering with line-of-sight visibility. Minimizing physical interference between the antenna and the satellite is an important consideration for improving data reception. However, significantly fewer geese with harnesses were successfully tracked to their wintering areas. Because the primary objective of the study was to document migration, we concluded that neck collars were the superior attachment to the 85-g package.

Service biologists monitored the distribution, abundance, and productivity of lesser snow geese on the Yukon-Kuskokwim Delta when geese were enroute from their nesting grounds on Wrangel Island, Russia, to wintering areas along the Pacific Coast. Geese arrived on the Delta around September 19 and remained on the Delta an average of 10 days.

Satellite Tracking and Staging Ecology of Wrangel Island Lesser Snow Geese

The population of lesser snow geese breeding on Wrangel Island, Russia, is one of the few waterfowl populations of Palearctic origin which is harvested on the North American continent but does not breed there. Management of lesser snow geese from Wrangel Island is additionally complicated because the population winters in two disjunct regions of the Pacific Flyway, the largest (California) component of which mixes with lesser snow and Ross' geese breeding in northern Canada. Harvest regulations have largely been directed toward this larger, Canadian segment of the "white goose" population in the Pacific Flyway. These actions potentially could compromise the Wrangel Island population which has been declining since the early 1970s.

Biologists from Northern Prairie Wildlife Research Center, Yukon Delta National Wildlife Refuge, and the Alaska Center monitored the distribution, abundance, and productivity of lesser snow geese on the Yukon-Kuskokwim (Y-K) Delta during September and October 1991, when the geese were en route from their nesting grounds on Wrangel Island, Russia, to wintering areas along the Pacific Coast. Earlier in 1991 biologists captured adult geese in brood flocks on Wrangel Island and fitted with either satellite (PTT) transmitters or conventional radio transmitters.
All geese with active PTT transmitters and 43% of the geese with conventional transmitters still functioning were detected on the Y-K Delta. Geese marked with PTT and conventional transmitters were first detected on the Y-K Delta on September 19 and 25, respectively. Mean arrival time for PTT-marked geese was October 2; geese remained on the Delta an average of 10 days (range 1 to 2 days).

There were four areas of concentrated use: one on the north Delta, two on the central Delta, and one on the south Delta. All PTT-marked geese were located at least once on the mid-Delta, while three used the north Delta and one used the south Delta. Geese carrying PTTs used the same areas as unmarked geese and geese carrying conventional radios, except for the south Delta where only satellite data were obtained.

Flocks averaged 1,211 birds and did not vary significantly in size during the study. Approximately 28% of the geese censused in photographic counts were immatures. Average productivity, as determined from the proportion of young in flocks using the Y-K Delta, has varied from 0.5 to 42.1%, with a mean of 29% since 1975. Production estimates from the Y-K Delta were highly correlated with those from autumn staging areas further south. Information from PTT-marked geese indicated that the entire breeding component of the Wrangel Island population used the Y-K Delta.

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Video and Digital Cameras Provide an Estimate of a Staging Goose Population on the Alaska Peninsula

In October 1992, Center biologists flew 69 video transects in Izembek Lagoon on the Alaska Peninsula to estimate the population of staging Pacific black brant. Biologists believe the entire population of Pacific black brant stage in this area before their southern migration to California and Mexico. Our biologists took about 4 hours to collect the video imagery in the 32-km long lagoon. The transects were flown at an altitude of 917 m, a 153-m increase in aircraft altitude from 1991. This change was successful in minimizing flushing of flocks. In 1991 flying birds made up 24% of all flocks and 30% of the total number of geese counted. In 1992 only 15 of 127 (11%) flocks were flying, contributing only 5% of the total count.

We judged a customized computer program, developed to automatically count goose images within a range of size and shape parameters selected by the user, to be effective in correctly identifying geese. Resolution of video images was not sufficient to identify brant from other species of geese. Therefore, we used the proportion of brant observed in aerial ocular counts to adjust the video estimate (65.5%). Although variance was high for population estimates by ocular methods and videography, means for each method were similar (112,115 and 119,077, respectively).

We collected images of select flocks of known species of geese under poor to bright light conditions using a digital camera with near infrared sensitivity. Results indicate that detection of geese can be improved by use of video or digital cameras sensitive to near-infrared radiation, which penetrates clouds and is reflected by the plumage of geese, but absorbed by water.

We may be able to improve confidence limits of future samples by using wider transect widths and increased sampling effort. Work in 1992 identified sampling procedures to minimize disturbance of geese, increase detectability, automate counting, and improve precision of estimates.

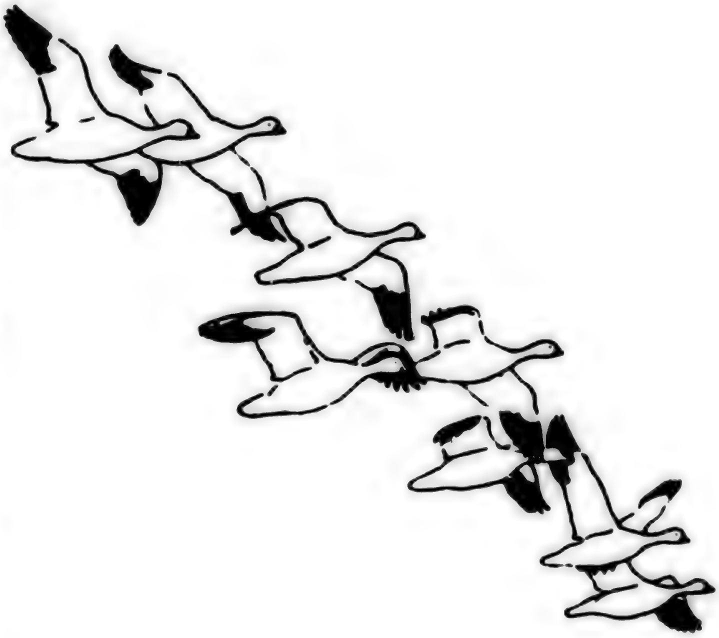
The Arctic Coastal Plain is Important to Staging Lesser Snow Geese

The coastal plain of the Arctic National Wildlife Refuge (ANWR) is used by up to 300,000 lesser snow geese prior to fall migration. ANWR is part of a larger staging area that extends along the coastal plain into Canada. During staging in late August, geese feed intensively and accumulate body fat needed for migration. Adult snow geese deposit up to 25 g of fat/day during staging and increase the size of their lipid reserves by as much as 400%. Juvenile snow geese accumulate lipids at a slightly lower rate of 13 g/day and increase their fat reserves by about 370% during staging. These rates of fat accumulation are among the highest reported for a waterfowl species.

Snow geese accumulate fat reserves at such rapid rate by feeding intensively on two major food items: the underground stembase of tall cotton-grass and the aerial shoot of northern scouring-rush. Daily freezing and thawing apparently affect the diet of snow geese. The birds primarily feed on northern scouring-rush during the mornings when the ground is frozen, but switch to cotton-grass stembases during the afternoon after thawing has occurred. These species have a favorable nutritional composition. The stembase of cotton-grass is high in soluble carbohydrates that are needed for accumulation of lipids, while northern scouring-rush is high in protein.

Physiological limits in gut capacity and forage passage rate may constrain forage intake by snow geese. Because of low digestive efficiency, geese must consume large amounts of forage; over 30% of their body weight daily. Thus, a fall population of 300,000 geese may require over 4,000 tons of forage during a 21-day staging period! It takes only about 1.3 hours for forage to pass through the digestive tract of a snow goose.

Snow geese feed on northern scouring-rush along river terraces. The birds primarily feed on cotton-grass in sites that are wet or flooded and where there is little shrub or tussock cover. Cotton-grass feeding sites tend to occur along the edge of thermokarst pits and water tracks. These sites are widely distributed throughout the tundra, but comprise a small percentage of the land surface. Only between 1 and 3% of one of our study areas was comprised of suitable feeding habitat. Center biologists sampled a large number of random plots in 1992 throughout the ANWR staging area to determine the availability of feeding habitat. Studies that simulated the effects of feeding found that cotton-grass may require over 2 years to regrow following removal by snow geese.



Food resources and feeding habitats on the coastal plain are widely distributed and comprise a small percentage of the tundra. Temporal variation in forage availability may be high due to periodic snow cover, freezing, and feeding that may affect habitat quality for up to 2 years. These findings explain why this population uses a staging area that extends across 700 km of coastal plain in Canada and Alaska. Snow geese likely require a large staging area in which to find suitable forage.

Intraspecific nest parasitism, the laying of eggs in the nests belonging to the same species, is well documented in waterfowl and results in individuals expending effort in raising young not their own. Center biologists investigated the frequency and occurrence, and evaluated costs and benefits of intraspecific nest parasitism as part of a larger study of the ecology of emperor geese in western Alaska.

Intraspecific Nest Parasitism Among Emperor Geese

Intraspecific nest parasitism, the laying of eggs in the nests belonging to the same species, is well documented in waterfowl and results in individuals expending effort in raising young not their own. The primary benefit to a nest parasite is the ability to produce young without the costs of incubation and brood rearing. For most waterfowl species this benefit may be offset by an even greater net benefit of producing and raising a brood non-parasitically. The costs to a host with precocial young (young that are able to move around and forage at a very early stage in their lives) are generally believed to be minor.

As part of a larger study of the ecology of emperor geese in western Alaska, the Center investigated the frequency and occurrence, and evaluated costs and benefits of intraspecific nest parasitism. Many of the emperor nests contained parasitic eggs, and over 14% of goslings produced on the western Alaska study area were from parasitic eggs. This nesting strategy occurred in a large proportion of the emperor goose population probably because of high spring mortality of paired adults. Parasitism had no significant effect on hatching success, and a slight, although significant, effect on host egg success; hatching success of parasitic eggs was 49%.

Geese laid eggs in other goose nests when the host female was absent, or they laid eggs adjacent to the host female when she was present. Host females rolled parasitic eggs into the nest immediately after the parasitic female left the nest area. The relatively high rate of nest parasitism may reflect a high proportion of females unpaired or newly re-paired in spring and unable to establish or maintain nesting territories. The cost of nest parasitism to the host, as measured by host egg mortality, was low.

Benefits to the host from raising large broods may include increased dominance status or decreased predation of host young. Costs to the parasite are offset by increased adult female survival. Based on estimates from annual adult survival, nesting frequency, and hatching success, a female that lays parasitically when unable to initiate incubation and a female who is only parasitic will produce more goslings in their lifetimes than a female that never lays parasitically.

We feel that intraspecific nest parasitism in emperor geese evolved as a salvage strategy in an unpredictable environment. Parasitism is currently maintained in this population by an unpredictable nesting environment due to variable weather and a relatively high proportion of unpaired and newly paired adult females that occurs each spring as a result of spring hunting on the nesting areas.

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Center Starts New Projects Addressing Ecology of Spectacled Eiders and Methods to Assess the Compatibility of Salmon Enhancement Strategies on Alaska National Wildlife Refuges

The Center plans to start two new multi-year efforts in FY 1993 to investigate the ecology of spectacled eiders and methods to assess the compatibility of salmon enhancement strategies on national wildlife refuges in Alaska.

The first project seeks to locate staging, molting, and wintering areas and determine nesting success and habitats of spectacled eiders. In recent years, the nesting population of spectacled eiders in Alaska has declined precipitously. The reasons for this decline are unclear; however, concerns regarding the status of this population have resulted in a recent proposal to list this species as "Threatened" under the Endangered Species Act. A substantial effort will be required to identify causes and reverse the serious decline in this population.

Our research effort will focus on locating and describing staging, molting, and wintering areas, the prevalence of diseases and parasites in the nesting population, and reproductive success and factors influencing that reproductive success. Current emphasis will be directed at the population of spectacled eiders nesting on the Lower Kashunuk River in the Yukon-Kuskokwim Delta in western Alaska.

The second project will seek to develop new methods and evaluate existing methods to assess salmon enhancement strategies on Alaskan refuges. Alaska is one of the few areas left in the U.S. where a large number of wild salmon stocks exist that have not been significantly altered by hatchery enhancement and where stock biodiversity may exist near historic levels. Service managers, however, receive increasingly frequent requests to increase numbers of salmon on national wildlife refuges by enhancing these wild populations with hatchery-reared fish. Even though enhancement programs create new sport and commercial wild stocks, there are biological risks. For example, there may be loss of genetic diversity in wild stocks, alterations in run timing and behavior of wild fish, or straying of hatchery fish to new streams.

Our study addresses the development of tools to examine the broad array of biological characteristics that define biodiversity in wild salmon stocks. Our hope is to provide managers with the capabilities to improve enhancement efforts, while maximizing diversity. We will characterize the historic methodologies, strategies, and environments used to enhance salmon on Alaska refuges, review behavioral, ecological, and genetic implications of historic enhancement projects, develop new methods to quantify the positive and negative effects of stocking on wild fish, and develop guidelines and a draft policy for use by Service administrators regarding future fisheries enhancement projects on refuge lands.

One of the Center's new starts in 1993 will seek to develop new methods and evaluate existing methods to assess salmon enhancement strategies on Alaska refuges. Service managers are receiving increasingly frequent requests to increase the number of salmon on national wildlife refuges by enhancing these wild populations with hatchery-reared fish.

FISHERIES

Most salmon stocks in Alaskan waters have rebounded from low numbers recorded in the 1970's. Maintaining these stocks at adequate levels is difficult because sport, subsistence, and commercial harvest, both foreign and domestic, is increasing. The Center is investigating several aspects of the biology of sockeye, chinook, and chum salmon with emphasis on the identification and distribution of stocks.

Polymerase Chain Reaction of Mitochondrial DNA for Genetic Stock Identification of Salmon

Fisheries scientists use genetic information to define taxonomic units, identify wild stocks, and describe relationships between stocks. Biologists define a stock as a separate breeding population. Genetic information has application in breeding programs, environmental impact assessment, genetic conservation, and management recommendations.

Protein electrophoresis is presently the most widespread technique used for genetic stock identification. This technique relies on variation in the DNA being reflected as variation in electrophoretic mobilities of the proteins produced by the DNA. The primary advantage of protein electrophoresis is that it permits genetic variation to be assessed across many loci and for many fish. Its limitations are that: (1) tissue must be in good condition, requiring rigorous transport and storage conditions; (2) different tissues must be used to access different loci for improved genetic resolution (which usually kills the fish); (3) only electrophoretic mobility variation can be detected, although variation may exist at the DNA level; and (4) variation at loci that do not produce proteins usually cannot be detected.

In contrast, molecular techniques permit access to the nucleotide sequence of DNA molecules, which results in better resolution of genetic variation than is possible with protein electrophoresis. Most analyses of DNA variation in natural populations have focused on mitochondrial DNA (mtDNA) because it can be isolated from the nuclear DNA and often shows intraspecific variation.

Conventional mtDNA methods have drawbacks for use by fisheries managers. Most mtDNA extraction techniques involve killing the fish to get the tissue sample. Polymerase chain reaction (PCR) in combination with restriction enzyme analysis is a new method developed within the last 4 years to generate restriction-fragment-length-polymorphism data and used to amplify segments of mtDNA that are then screened with restriction enzymes. Compared with other molecular DNA analyses, the technique is simple and less labor intensive because genomic DNA can be used, requires less DNA, allows less rigorous quality requirements for DNA, and provides faster analysis of samples.

Geneticists at the Alaska Center analyzed mtDNA variation in chum salmon and chinook salmon with PCR and restriction enzymes. The frequency differences of genotypes that we observed within the Yukon River alone suggest that PCR has utility for defining population structure and subsequent use for genetic stock identification. The fixed genotype differences observed in chinook salmon between Alaska and the Pacific Northwest indicate that PCR could also be used as a forensic tool to identify the country of origin in high-seas interceptions or in investigations of illegal marketing.

An important aspect of the PCR analysis is the ability to acquire useful genetic information from an individual without killing it. This has obvious benefits for breeding programs: genetic marking of hatchery stocks; investigations of rare, threatened, or endangered species; and correlating genetic information with environmental and physiological data for the same individual over time.

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Mitochondrial DNA Variants in Stocks of Chinook Salmon

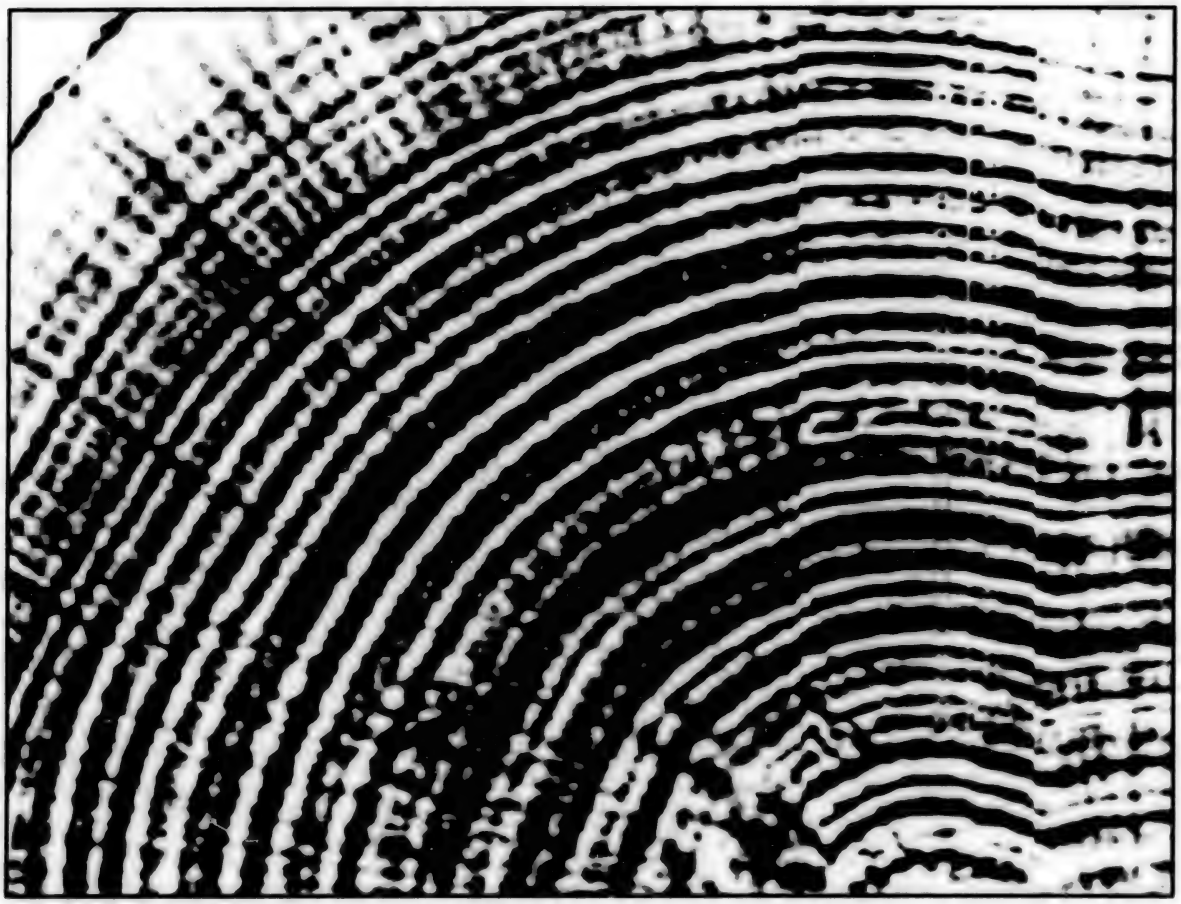
Two runs of chinook salmon occur in the Kasilof River watershed in the Kenai National Wildlife Refuge. The late run spawns in the main stem of the river just downstream of Tustumena Lake in early September and is composed of wild-spawning fish. The early run, now supported almost entirely by hatchery enhancement, returns in mid-June to a hatchery located on Crooked Creek, a tributary to the Kasilof River. State biologists have used the Crooked Creek State Hatchery to enhance the early run since 1974.

For each of the two runs, Center biologists extracted genomic DNA from muscle samples taken from adults in 1990 and 1991. Muscle samples of the progeny produced by the early and late runs from both years were also obtained and genomic DNA extracted. Biologists analyzed mitochondrial DNA (mtDNA) of both juvenile and adult salmon from both years to determine if genetic differences were detectable between the two runs. We amplified three portions of the mtDNA molecule separately using the polymerase chain reaction and then digested with 14 restriction enzymes. Two restriction fragment patterns revealed a clear separation between the two Kasilof River populations.

MtDNA analysis identified genetic differences between early- and late-run chinook salmon in the Kasilof River. The spawning grounds of the two runs are only 19 km apart; however, Kasilof River late-run chinook salmon were genetically distinct from Kasilof River early-run fish and from chinook in the Kenai River, a neighboring drainage, and Grande Ronde River, Oregon.

The genetic difference between the Kasilof River late run and the early runs in the Kenai and Kasilof rivers gives managers and biologists the opportunity to monitor the Kasilof River late run on an individual basis. Also, samples taken from the mixed-stock fishery occurring in Cook Inlet and the sport fishery in the

Kasilof River can be analyzed to determine the contribution of the Kasilof late-run population to the total harvest. Results of our study suggest that there may be sufficient variation to develop a genetic baseline for stocks of chinook salmon originating in Cook Inlet.



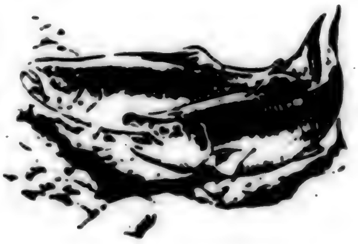
The otolith, the ear bone of a fish, is helping fishery biologists discriminate hatchery- from wild-incubated sockeye fry in Tustumena Lake on Kenai National Wildlife Refuge. Our biologists are using a computerized image analysis system to quantify banding patterns on polished otoliths like the one pictured here.

Otolith Microstructure Discriminates Between Hatchery and Wild Sockeye Salmon

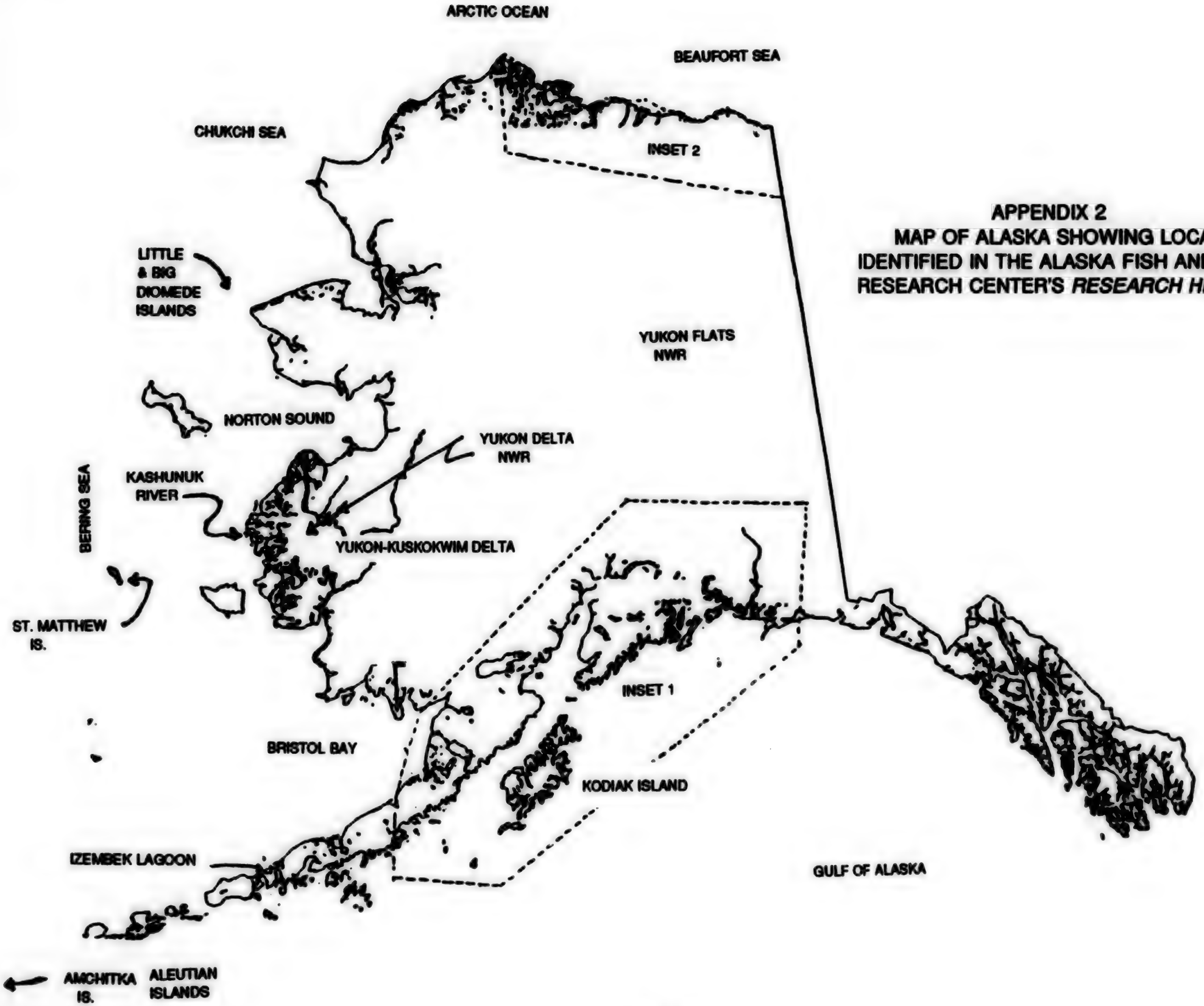
Tustumena Lake is the second largest producer of sockeye salmon in Upper Cook Inlet. Since 1976 the Alaska Department of Fish and Game has supplemented natural production of sockeye with Tustumena Lake brood stock incubated at the Crooked Creek Hatchery. Assessment of possible competitive interactions between hatchery- and wild-incubated sockeye salmon fry necessitates the ability to distinguish between these populations. Differences in water temperature during incubation may result in distinct otolith (ear bone) banding patterns.

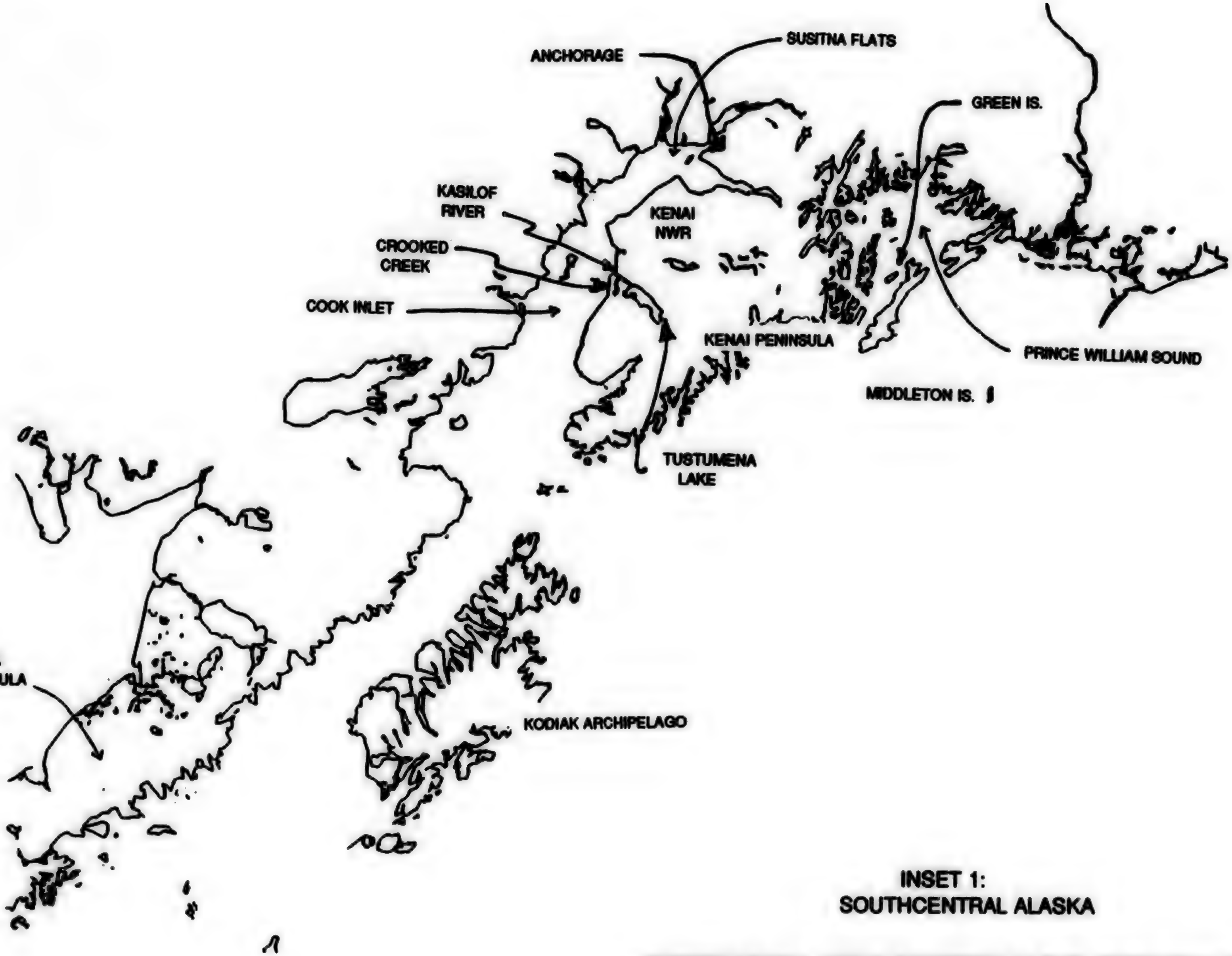
Our fishery biologists are analyzing the otolith microstructure formed during incubation to test the feasibility of developing a model to discriminate hatchery- from wild-incubated sockeye salmon fry in Tustumena Lake. We collected samples of fry migrating from natal streams into the lake from 1990 to 1992. We sampled hatchery-incubated fry just prior to their release into the lake over the same time period. A computerized image analysis system was used to quantify banding patterns on polished otoliths.

We performed a preliminary analysis of 65 otoliths from 15 hatchery and 50 wild sockeye fry. Of the 28 variables tested, 12 were statistically different. Preliminary results demonstrate a strong potential for separating hatchery from wild sockeye salmon fry using existing otolith banding patterns. The variables examined to date do not appear to separate the wild groups. We will conduct additional research using larger sample sizes, different variables, and other sockeye salmon populations (for example, lake-shore incubated fry) from Tustumena Lake.



APPENDIX 2
MAP OF ALASKA SHOWING LOCATIONS IDENTIFIED IN THE ALASKA FISH AND WILDLIFE RESEARCH CENTER'S *RESEARCH HIGHLIGHTS*





INSET 1:
SOUTHCENTRAL ALASKA

GEOGRAPHICAL AREAS IDENTIFIED IN THE *RESEARCH HIGHLIGHTS*

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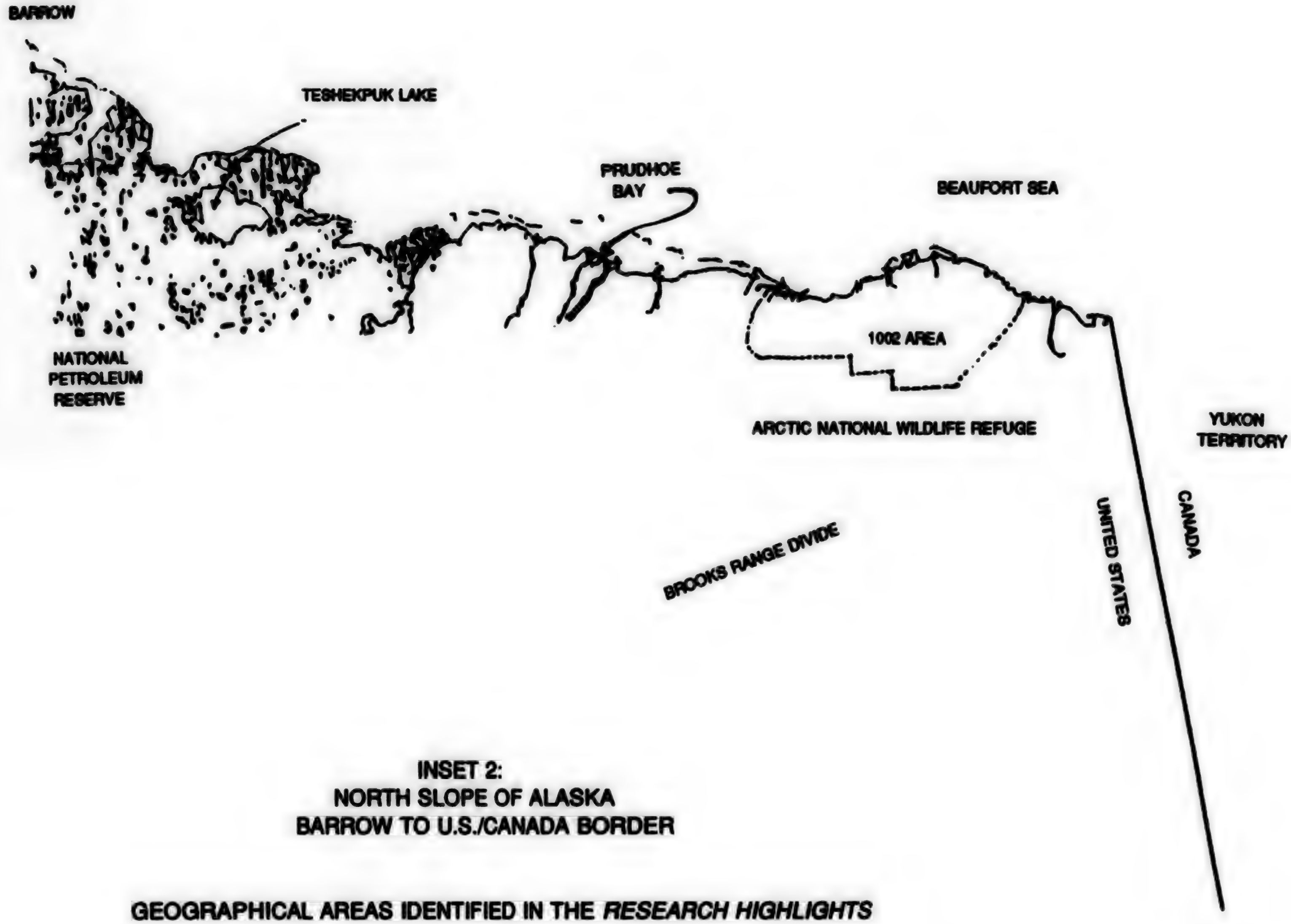
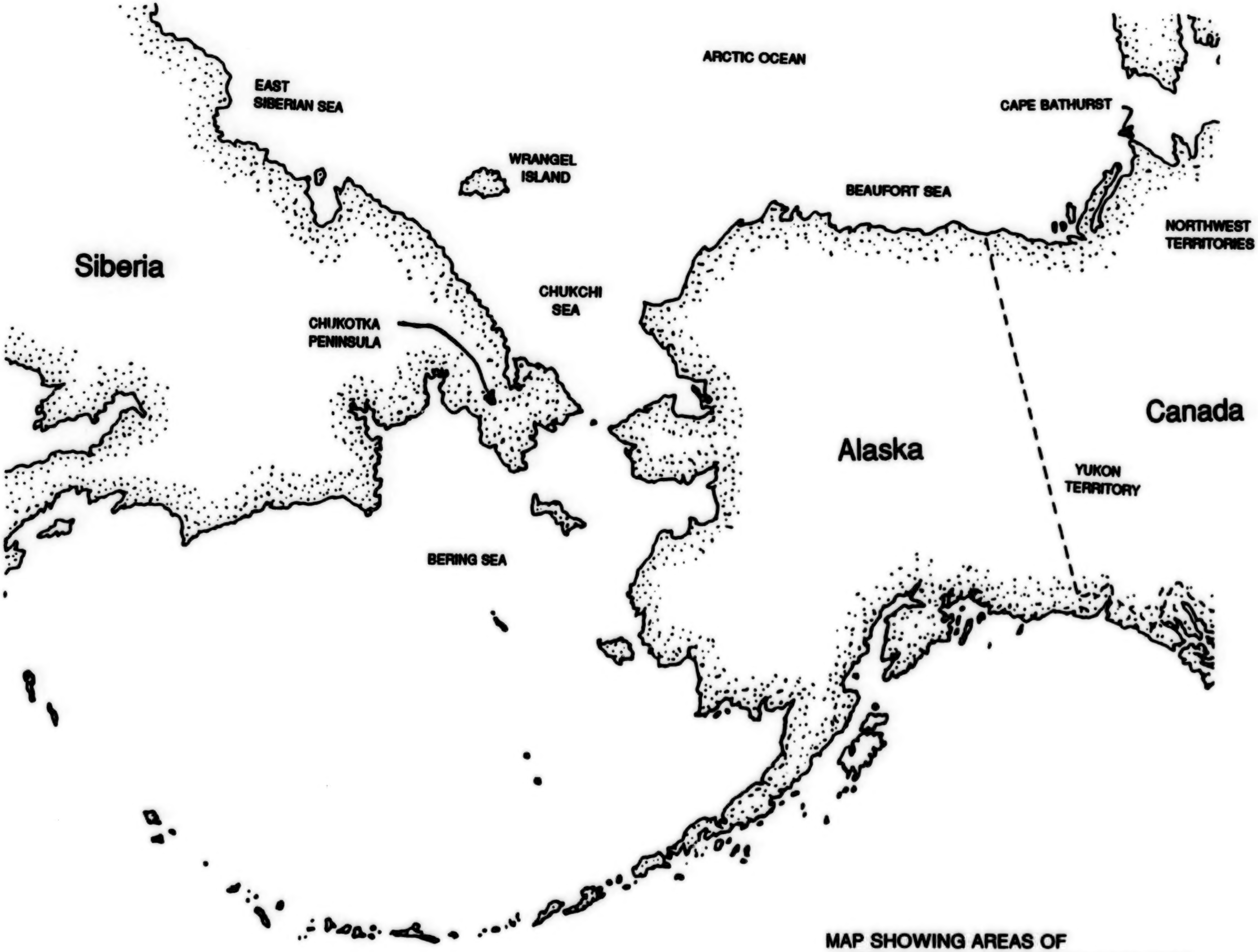


INSET 2:
NORTH SLOPE OF ALASKA
BARROW TO U.S./CANADA BORDER

GEOGRAPHICAL AREAS IDENTIFIED IN THE *RESEARCH HIGHLIGHTS*



MAP SHOWING AREAS OF INTERNATIONAL RESEARCH ACTIVITIES WITH RUSSIA AND CANADA.

APPENDIX 3

Alaska Fish and Wildlife Research Center
Fiscal Year 1992 Listing of Active Work Units

MAMMALS

00018 Determine the distribution, timing, and importance of polar bear denning in Alaska.
00019 Population definition and estimation of survival, recruitment, and numbers of polar bears in the Beaufort Sea.
00020 Relationships between polar bears, sea ice movement and condition, and pagophilic seals.
00021 Population definition and estimation of survival, recruitment, and number of polar bears in northwestern and northern Alaska.
00022 Interrelationships between sea ice habitats and polar bear distributions in the Bering and Chukchi seas in northwestern Alaska.
00023 To provide the biological information necessary to establish a zonal management program for sea otters in Alaska.
00024 Interactions between sea otters and fisheries in Alaska.
00042 Magnitude, extent, and duration of impacts from the "Exxon Valdez" oil spill on sea otter populations.
00026 Development of techniques to monitor movements for population assessment of Pacific walruses.
00027 Integration of telemetry, remote communication, remote sensing, and geographic information systems.
00028 The distribution and seasonal quality of habitat available for key wildlife species on the Arctic coastal plain.
00053 Advanced very high resolution radiometer satellite imagery for documenting snow cover conditions during caribou calving in arctic Alaska.
00047 Influence of global change on wildlife populations in arctic regions.
00052 Effects of global climate change on ungulate resources of the arctic coastal plain.
00029 Status and ecology of Kodiak brown bears.
00030 Potential impacts of petroleum exploration and development on the numbers, distribution, and status of caribou on the Arctic coastal plain.
00031 Habitat requirements and potential impacts of oil development on caribou.
00032 Potential effects of petroleum exploration and development on muskoxen using the 1002 area.
00046 Statistical methods for studies of arctic and subarctic mammals.

MIGRATORY BIRDS

00002 Status, population dynamics, and ecology of Alaskan geese.

00003 Distribution, abundance, habitat requirements and survival of geese staging at Upper Cook Inlet and Alaska Peninsula estuaries.

00004 Population and production of waterfowl on National Wildlife Refuges in Alaska.

00005 Ecology and behavior of foxes in goose nesting areas on the Yukon-Kuskokwim Delta, Alaska.

00006 Impacts of human activities on the behavior, energetics, and habitats of Pacific black brant and other geese near Teshekpuk Lake, Alaska.

00048 Winter ecology of Pacific black brant in Mexico.

00007 Potential impacts of petroleum development on lesser snow geese staging on the Arctic coastal plain.

00008 Nesting ecology and habitat requirements of geese on the Yukon-Kuskokwim Delta.

00055 Population dynamics and ecology of spectacled eiders.

00040 Populations and production of northern pintail in Alaska.

00009 Relationships between seabirds and their prey in Alaskan waters.

00051 Interactions of seabirds and walleye pollock in the Gulf of Alaska and Bering Sea.

00011 Adult survival and breeding energetics of black-legged kittiwakes on Middleton Island, Alaska.

00012 Monitoring seabird population in Alaska: A manual of methods.

00014 Population status and ecology of shorebirds in Alaska.

00017 Status and demographics of the bristle-thighed curlew.

00043 Use of mitochondrial DNA to investigate genetic relationships between populations of birds, mammals, and fish of Alaska.

00049 Waterfowl habitat and global climate change on the Yukon-Kuskokwim Delta.

00050 Status and biodiversity of neotropical passerine populations in Alaska.

FISHERIES

00035 Origin, spawning distribution, and migration patterns of United States and Canadian stocks of chum and chinook salmon in the Yukon River, Alaska.

00037 Sockeye and chinook salmon studies in the Tustumena Lake drainage.

00045 Evaluation of habitat suitability models for lake trout and chinook salmon.

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